be removed to a large extent in the subsequent Kraft cook by a variety of hemicellulose hydrolysis reactions or by dissolution.

The prehydrolysis stage normally involves treatment of wood at elevated temperature (150—180°C) with dilute mineral acid (sulfuric or aqueous sulfur dioxide) or with water alone requiring times up to 2 hours at the lower temperatures. In the latter case, liberated acetic acid from certain of the naturally occurring polysaccharides (predominantly the mannans in softwoods and the xylan in hardwoods) lowers the pH below 4.

Moreover, a relatively low copper number, reflective of the relative carbonyl content of the cellulose, is a desirable property of a pulp that is to be used to make lyocell fibers because it is generally believed that a high copper number causes cellulose and solvent degradation, before, during, and/or after dissolution in an amine oxide solvent. The degraded solvent can either be disposed of or regenerated; however, due to its cost it is generally undesirable to dispose of the solvent. Regeneration of the solvent suffers from the drawback that the regeneration process involves dangerous, potentially explosive conditions.

A low transition metal content is a desirable property of a pulp that is to be used to make lyocell fibers because, for example, transition metals accelerate the undesirable degradation of cellulose and NMMO in the lyocell process.

In view of the expense of producing commercial dissolving grade pulps it would be desirable to have alternatives to conventional high alpha dissolving grade pulps as a lyocell raw material. In addition, pulp manufacturers would like to minimize the capital investment necessary to produce such types of pulps by utilizing existing capital plants.

In order to control lyocell fiber properties, lyocell manufacturers utilize dopes that comprise a blend of different pulps having different ranges of average degree of polymerization values. In view of this, there is also a need for pulp manufacturers to produce pulps having an average degree of polymerization within a relatively narrow band.

Thus, there is a need for relatively inexpensive, low alpha (e.g., high yield) pulps that can be used to make lyocell fibers, for a process of making the foregoing low alpha pulps using capital equipment that is currently available to pulp manufacturers, and for lyocell fibers from the foregoing low alpha pulp. Preferably, the desired low

alpha pulps will have a desirably low copper number, a desirably low lignin content and a desirably low transition metal content.

In the prior application Serial No. 09/256,197, assigned to the assignee of the subject application, various methods of reducing D.P. values and copper number of a Kraft pulp are described. Such methods include treating pulp with acid, or an acid substitute, or a combination of acids and acid substitutes. Other means of treating the pulp to reduce the average D.P. of cellulose without substantially reducing the hemicellulose content described in the prior application include treatment of the pulp with steam, a combination of ferrous sulfate and hydrogen peroxide, at least one transition metal and peracetic acid, an alkaline chlorine dioxide treatment which ends acidic or a sodium hypochlorite treatment which ends near neutral. Such processes are effective at reducing the average degree of polymerization without substantially reducing the hemicellulose content, however, such processes can be expensive from a capital improvement standpoint if the existing pulp mills in which such processes are to be used are not configured to allow for the simple deployment of such processes. In the prior application, additional steps are described in order to reduce the copper number of the pulp which have been treated to reduce its average degree of polymerization without substantially decreasing the hemicellulose content. The need for this subsequent copper number reducing step arose because the methods described in the prior application for reducing the average degree of polymerization for the cellulose resulted in an increase in the copper number for the resultant pulp.

In view of environmental concerns, there has been a great interest in using bleaching agents, which reduce the amount of chlorocompounds that must be recovered from process streams. In recent years, the use of oxygen as a delignifying agent has occurred on a commercial scale. Examples of equipment and apparatus useful for carrying out an oxygen stage delignification are described in U.S. Patent Nos. 4,295,927; 4,295,925; 4,298,426; and 4,295,926.

While the methods described in the prior application are effective at reducing the average D.P. of cellulose without substantially decreasing the hemicellulose content, a need exists for a process that does not require a separate copper number reducing step and which is readily adaptable to pulp mills that include oxygen reactors,

multiple alkaline stages and/or alkaline conditions suitable for substantial D.P. reduction of bleached or semi-bleached pulp.

## SUMMARY OF THE INVENTION

As used herein, the terms "composition(s) of the present invention", or "composition(s) useful for making lyocell fibers", or "treated pulp" refer to pulp, containing cellulose and hemicellulose, that has been treated under alkaline conditions in order to reduce the average degree of polymerization (D.P.) of the cellulose without substantially reducing the hemicellulose content of the pulp or substantially increasing the copper number for the pulp. The compositions of the present invention preferably possess additional properties as described herein.

Compositions of the present invention are compositions useful for making lyocell fibers, or other molded bodies such as films, having a high hemicellulose content, a low copper number and a narrow molecular weight distribution, including cellulose that has a low average D.P. Preferably, the cellulose and hemicellulose are derived from wood, more preferably from softwood. Additionally, the compositions of the present invention exhibit a variety of desirable properties including a low lignin content, and a low transition metal content. Compositions of the present invention may be in a form that is adapted for storage or transportation, such as a sheet, roll or bale. Compositions of the present invention may be mixed with other components or additives to form pulp useful for making lyocell molded bodies, such as fiber or films. Further, the present invention provides processes for making compositions useful for making lyocell fibers having desirable hemicellulose content and copper number, and including cellulose that has a desirable average D.P. and molecular weight distribution.

The present invention also provides lyocell fibers containing cellulose having a low average D.P., a high proportion of hemicellulose and a low copper number, a narrow molecular weight distribution, and a low lignin content. The lyocell fibers of the present invention also preferably possess a low transition metal content.

Compositions of the present invention can be made from any suitable source of cellulose and hemicellulose but are preferably made from an alkaline chemical wood pulp such as Kraft or soda, and more preferably from a Kraft softwood pulp. Compositions of the present invention include at least 7% by weight hemicellulose,